REMOTE TRANSMITTER POWER CONTROL IN A CONTENTION BASED MULTIPLE ACCESS SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to wireless communications. More particularly, the present invention relates to power control in a CDMA communication system.

2. Description of the Related Art

A packet is one method of packaging user data. Typically, the packet is divided up into various fields, with each field comprising one or more bits. Each field is used for a predetermined function such as user data, addresses, error detection, etc. Data packets can be formed according to pre-existing protocols such as X.25 and TCP/IP that are well known in the art.

Packets may be used with a true packet service in which the application, transport, or other layer generates the packet. Packets can also be generated by a network's lower protocol layer that breaks a stream of data bits into data packets of predetermined length.

Data packets can be transmitted over a radio channel using many methods. A first method uses a dedicated channel to carry packets between a pair of radio transceivers. A second method encompasses a single, central radio transceiver that transmits over a common channel to one or more other radio transceivers that are monitoring for packets containing data in the address field signifying that radio transceiver's particular address. A third method uses a random access or contention based protocol in which the packets are transmitted from one or more radio transceivers to either a central terminal or each other.

In a typical CDMA cellular communication system that follows the Telecommunications Industries Association/Electronic Industries Association Interim Standard 95 (TIA/EIA/IS-95), the dedicated channel corresponds to a traffic channel. This channel transmits voice and data signals between the mobile radio and the base station. The common channel approach corresponds to transmitting on the paging channel that is used to broadcast pages in a CDMA system when each page carries an address. The random access approach corresponds to the access channel. A typical CDMA-type communication system is described in greater detail in U.S. Pat. No. 5,103,459 to Gilhousen et al. and assigned to Qualcomm, Inc.

When one or more packets are to be transmitted between a base station and mobile radio or vice versa, a traffic channel can be allocated between the two. Once a packet is transmitted, the time to the next packet is often unknown. Instead of having the traffic channel allocated and unused, the channel is deallocated after a period of idleness. This period can be fixed with the period determined by analyzing typical traffic patterns. Alternatively, this period can also be variable with the period set by analyzing the transmitted packet stream.

The allocation of traffic channels presents at least two problems. First, the traffic channel takes time to set up, thus delaying the packet transmission. In some instances, setting up a traffic channel could require more than a second. Second, the resources to set up and use a traffic channel may be too expensive to justify the transmission of infrequent packets, short packets, or short sequences of packets.

Power control in a CDMA system is very important since a large number of mobile radios are transmitting on the same frequency. If one mobile is transmitting at a power output that is too large, it can degrade the received $^{Eb}/_{Io}$ from other mobile radios to the point that the base station cannot correctly demodulate transmissions. If the mobile radio transmits at too low of an output power, the received $^{Eb}/_{Io}$ from the mobile radio at the base station will be too low to properly demodulate the $^{Eb}/_{Io}$ received signal. The mobile radio's transmit power, therefore, has an affect on system capacity.

The correlation between $^{Eb}/_{Io}$ and system capacity can be shown as follows. When there are no mobile radios in other cells, the maximum number of simultaneous transmissions, N, is approximately:

$$N \approx \frac{W/R - (E_b/I_o)_{des}(N_o W/P_r)}{(E_b/I_o)_{des}}$$

where:

W=spreading bandwidth,

R=data rate,

$(^{Eb}/_{Io})_{des}$=desired quality metric subsequently explained in greater detail,

N_0=thermal noise spectral density of the base station receiver, and

P_r=received power per transmission.

The second term in the numerator is typically very small compared to $^{W}/_{R}$, therefore,

$$N \approx \frac{W/R}{(E_b/I_o)_{des}} .$$

Thus, a system using a higher desired $^{Eb}/_{Io}$ lowers capacity.

For the i^{th} mobile radio, the received $^{Eb}/_{Io}$, denoted by $(^{Eb}/_{Io})_i$, at the base station is approximately

$$(E_b/I_o)_i \approx \frac{P_{ri}/R}{\sum_{j \neq i} P_{rj}/W} .$$

The probability that the transmission can be successfully demodulated is high if $(^{Eb}/_{Io})_i$ exceeds $(^{Eb}/_{Io})_{des}$ as is described above. If P_{ri} is large, however, the $^{Eb}/_{Io}$ is degraded for other mobile radios. If the received $^{Eb}/_{Io}$ falls below $(^{Eb}/_{Io})_{des}$, the probability that the transmission will not be successfully demodulated is high.

The mobile radio dynamically adjusts its transmit power using closed and open loop power control in order to maintain the proper received $^{Eb}/_{Io}$ at the base station as channel conditions change or the range to the base station changes. Open loop power control adjusts the mobile radio's transmit power autonomously by measuring the received power on the forward channel. Closed loop power control adjusts the mobile radio's transmit power by a feedback bit stream from the base station. The base station measures the received $^{Eb}/_{Io}$ to determine the feedback bit stream. Closed loop and open loop power control together determine the mobile radio's transmit power, as disclosed in U.S. Pat. No. 5,056,109 to Gilhousen et al. and assigned to Qualcomm, Incorporated.

Closed loop power control compensates for the differences in fading between the forward and reverse links, such as occurs when they are different frequencies. Additionally, it serves to compensate for the differences in transmit and receive path gains in the mobile radio and base station.

Closed loop power control is possible in a typical communication system since there is one traffic channel per mobile radio. This one-to-one channel pairing permits the